



IC-230

PLL
SYNTHESIZED

INSTRUCTION
MANUAL



SECTION II - DESCRIPTION

This transceiver employs a Phase Locked Loop Synthesizer which is capable of 30 kHz spaced full coverage operation between 146 MHz to 148 MHz. In addition, the transmit frequency may be increased or decreased by 600 kHz on each channel for use with repeaters. The IC-230 is extremely rugged and completely solid state.

State of the art devices such as Integrated Circuits, Field Effect Transistors, varactor and zener diodes are engineered into a tight knit straight forward electronic design throughout both transmitter, and receiver. Reliability, low current demand, compactness, unexcelled performance and ease of operation are the net result.

The dual conversion receiver with its FET front end and high-Q helicalized cavity resonators boasts low noise and sensitivity of $0.4\mu\text{V}$, or less. Signal gain of 90 db or more is accomplished from the second mixer back by virtue of a 6 stage IF amplifier. The need for additional front end RF amplification is thus eliminated. A zener regulated crystal-controlled first and second local oscillators produce unmatched stability. Audio reproduction is of an unusually high order of distortion free clarity.

The transmitter section will produce a minimum of 10 watts RF output. High-Q and shielded stages provide minimum interstage spurious response. An encased low pass filter is placed at the output to further insure undesirable frequency products are not emitted. An ingenious final PA transistor protection device, (APC), is incorporated in the final output circuitry. A tiny VSWR bridge and four DC amplifier constantly monitor the output for high VSWR, a shorted or absent antenna load, or other difficulty that would cause irreparable final transistor damage. Should these difficulties occur, the APC instantaneously disables the final PA without damage.

All circuitry is constructed in a series of modules which are easily removable for servicing. The modules are housed in a sturdy aluminum frame, which is, in turn, housed in a rigid metal case, providing an extremely durable and rugged unit. Great care has been taken to filter and regulate internal DC voltages. A DC input filter is provided to eliminate alternator or generator "whine" when used in a vehicle. Test points are brought up from all major circuits to facilitate maintenance checks and trouble shooting should the necessity arise.

A modern styled face plate, large S meter, small size and low profile design complete the unit's styling. The IC-230 is a welcome addition to any automobile or fixed station.

SECTION III - INSTALLATION

3.1 Unpacking:

Carefully remove your transceiver from the packing carton and examine it for signs of damage. Should any damage be apparent, notify the delivering carrier or dealer immediately, stating the full extent of the damage. It is recommended you keep the shipping cartons. In the event storage, moving or reshipment becomes necessary, they come in handy. Accessory hardware, cables, etc., are packed with the transceiver. Make sure you have not overlooked anything.

3.2 Location:

Where you place the transceiver in your automobile is not critical and should be governed by convenience and accessibility entirely. Since the unit is so compact, many mobile possibilities present themselves. In general, the mobile mounting bracket will provide you with some guide as to placement. Any place where it can be mounted with metal screws, bolts, or pop-rivets will work. For fixed station use, the IC-3PA AC power supply is so designed to be a stand for the transceiver.

3.3 Power Requirement:

The transceiver is supplied ready to operate from any regulated 13.5 VDC, 2.5 ampere negative ground source. An automobile 12 volt negative ground system is usually more than adequate. Some note must be taken, however, to the condition of the vehicle's electrical system. Items such as a low battery, worn generator/alternator, poor voltage regulator, etc., will impair operation of your transceiver. High noise generation or low voltage delivery can be traced to these deficiencies. If an AC power supply other than the matching IC-3PA is used with your transceiver, make certain it is adequately regulated for both voltage and current. Low voltage while under load will not produce satisfactory results from your transceiver. Receiver gain and transmitter output will be greatly impaired.

CAUTION: EXCESSIVE VOLTAGE (ABOVE 15VDC) WILL CAUSE DAMAGE TO YOUR TRANSCEIVER. BE SURE TO CHECK THE SOURCE VOLTAGE BEFORE PLUGGING IN THE POWER CORD

Included with your transceiver is a DC power cable with plug attached. The Red Wire is positive (+), the Black, negative (-). If your mobile installation permits, it is best to connect these directly to the battery terminals. This arrangement eliminates random noise and transient spikes sometimes found in automotive accessory wiring. If such an arrangement is not possible, then any convenient B+ lead in the interior of the vehicle and the negative frame can be utilized. Your transceiver provides an internal DC filter that will take out most of the transient noise. Remember, the unit operates on a negative ground system only - it cannot be used in a positive ground automobile. After making your connections, simply insert the plug into your transceiver (see Fig. 3).

When your transceiver is used with its matching AC power supply, the IC-3PA the power cable from the IC-3PA is simply plugged in the same receptacle in the transceiver and the AC line cord into any convenient wall receptacle.

3.4 Antenna:

The most important single item that will influence the performance of any communication system is the antenna. For that reason, a good high-quality, gain antenna of 50 ohms impedance is recommended, for fixed or mobil use. In VHF as well as the low bands, every watt of ERP makes some difference. Therefore, 10 watts average output plus 3 db of antenna gain equals 20 watts ERP, presuming low VSWR of course. The few more dollars investment in a gain type antenna is well worth it.

When adjusting your antenna, whether mobile or fixed, by all means follow the manufacturer's instructions. There are some pitfalls to be aware of. For example, do not attempt to adjust an antenna for lowest VSWR when using a diode VSWR meter not engineered for VHF applications. Such readings will invariably have error of 40% or more. Rather, use an in line watt meter similar to the Drake WV-4 or Bird Model 23 with VHF cartridge. Further, when adjusting a mobile antenna, do so with the motor running preferably above normal idling speed. This will insure proper voltage level to the transceiver.

Do not become alarmed if your transceiver fails to transmit at times during the antenna tune up procedure. Remember, your transceiver has a built-in Automatic Protection Circuit (APC) that will disable the transmitter if excessive VSWR, a shorted coaxial line or connector, or other antenna deficiency is present. A quick check on a good 50 ohm dummy load will show the transceiver to be working. The difficulty will lie with the antenna or its transmission line.

3.5 Microphone:

A high quality dynamic microphone is supplied with your transceiver. Merely plug it into the proper receptacle on the front panel.

This microphone is of 500 ohms impedance with a normal output of 6 mV. Should you wish to use a different microphone, make certain it is of equal impedance and output level. Under no circumstances use a "gain pre-amp" or ceramic type microphone. The audio system in your transceiver is more than adequate and additional pre-amplification unnecessary. To use this class of microphone is to invite distortion and possible damage to the transceiver.

3.6 L0 Spare Crystal Socket

There are 4 spare crystal sockets besides the 7 installed crystals in the L0 module. When the MHz Indicator shows 146, No. 8 socket is for "A" on the 100 KHz Selector and No. 9 is for "B". When the Indicator shows 147, No. 10 socket is for "A" on the 100 KHz Selector and No. 11 socket is for "B" on the selector. Each crystal adds 10 channels with 30 KHz separation.

The frequencies are calculated as follows:

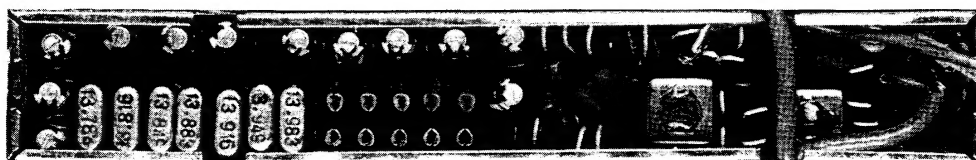
$$f \text{ (MHz)} = \frac{\text{Desired Operating Freq.} - \text{CO}_{1 \sim 10} \text{ Freq.} - 10.7 \text{ (MHz)}}{9}$$

For exampl, if you desire to operate on 146.02 MHz

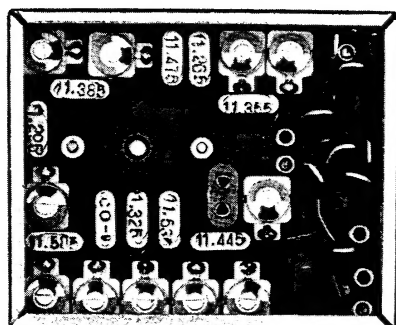
$$f \text{ (MHz)} = \frac{146.02 \text{ (MHz)} - 11.265 \text{ (MHz)} - 10.7 \text{ (MHz)}}{9} = 13.784 \text{ (MHz)}$$

If you put a crystal of 13.784 MHz into the spare socket No. 8 or No. 9, 10 frequencies with 30 KHz separation will be produced. They are 146.02, 146.05, 146.08, 146.11, 146.14, 146.17, 146.20, 146.23, 146.26 and 146.29 MHz.

LO MODEL



CO MODEL



3.7 CO Spare Crystal Socket

There is a spare crystal socket along with the 10 installed crystals in the CO module. The spare socket is for "C" on the 10 KHz Selector for both 146 and 147 MHz. This crystal adds 7 channels with 300 KHz separation.

The frequencies are calculated as follows.

$$f \text{ (MHz)} = \text{Desired Operating Freq.} - (\text{LO}_{1\sim7} \text{ Freq.} \times 9) - 10.7 \text{ (MHz)}$$

For example, if you desire to operate on 146.05 MHz

$$f \text{ (MHz)} = 146.05 \text{ (MHz)} - 13.783 \text{ (MHz)} \times 9 - 10.7 \text{ (MHz)} = 11.305 \text{ (MHz)}$$

If you put a 11.305 MHz crystal into the CO spare socket, 7 frequencies with 300 KHz separation will be produced. They are 146.05, 146.350, 146.650, 146.950, 147.250, 147.550 and 147.850 MHz.

To order additional crystals from a manufacturer, the following correlation data is provided. Remember to specify high activity as prerequisite to your acceptance.

Crystal Data

Holder Type:	HC-25/u
Calibration Tolerance:	0.0025%
Load Capacitance:	20 pf
Effective Resistance:	15 ohms or less
LO Frequency:	13.783 – 13.983 MHz
CO Frequency:	11.265 – 11.535 MHz
Cut:	"AT" optimum angle ± 2 min.

CAUTION: BEFORE YOU INSTALL ANY SPARE CRYSTAL, CHOOSE A FREQUENCY THAT WILL NOT ALLOW ANY POSITION ON THE 100 KHz OR 10 KHz SELECTOR TO PRODUCE A FREQUENCY THAT IS OUT OF THE 146 MHz - 148 MHz BAND, WHILE USING THE NEWLY INSTALLED CRYSTAL.

Due to the 30 kHz separation in the United States, not all selectable frequencies are available. If the meter light goes out after selecting a frequency, you will know that that frequency is outside the 30 kHz separation.

3.8 External Speaker:

An external speaker jack and plug is supplied with your unit in the event another speaker is desirable. The external speaker impedance should be 8 ohms. The use of the external speaker jack will disable the internal speaker. An 8 ohm headset can be utilized as well.

SECTION IV - CONTROL FUNCTIONS

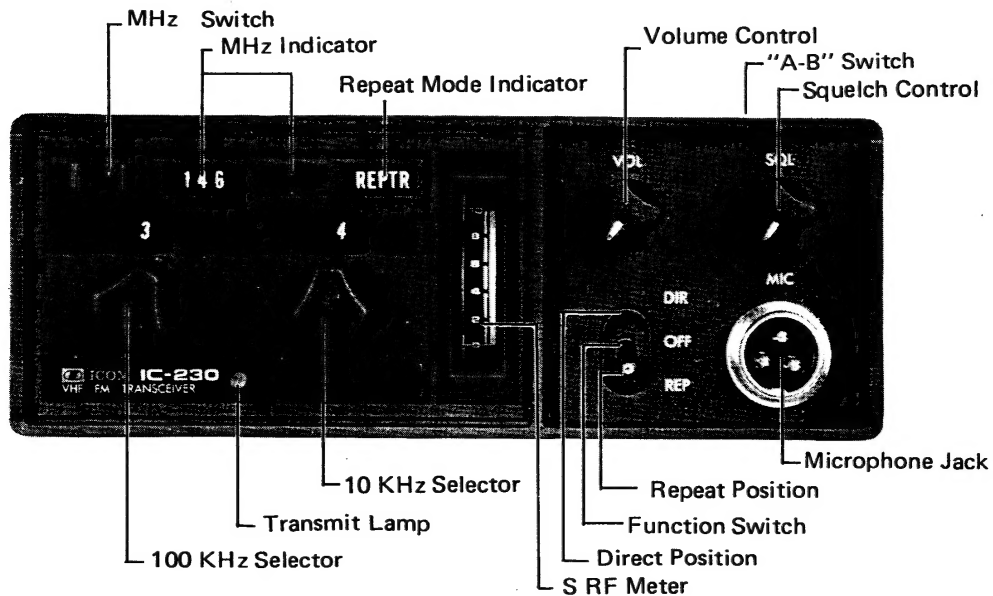
4.1 Front Control

Volume Control: controls audio output level of the receiver.

Squetch Control: controls the squetch threshold point of the receiver.

Microphone Jack: accepts 3 prong mike plug.

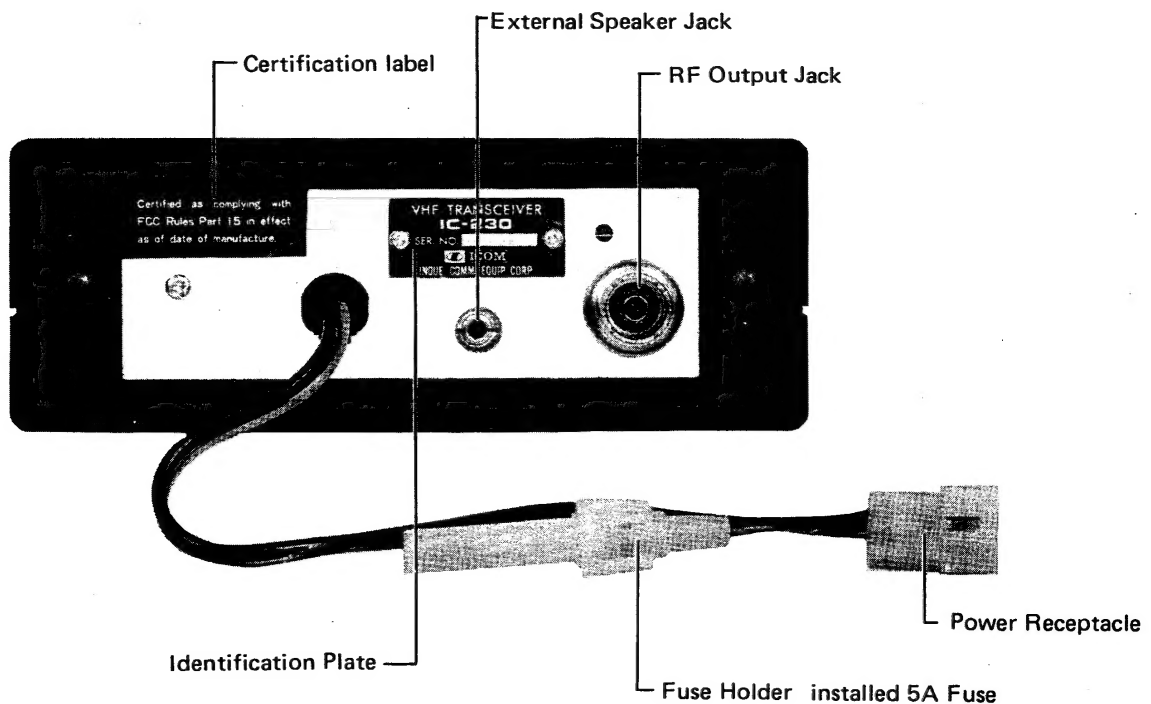
S-RF Meter: reads S signal strength in receive mode and relative RF output in transmit mode. The meter light is on only when the frequency selected is available.



4.2 Rear Panel

RF Output Jack: accepts standard PL-259 coaxial connector.

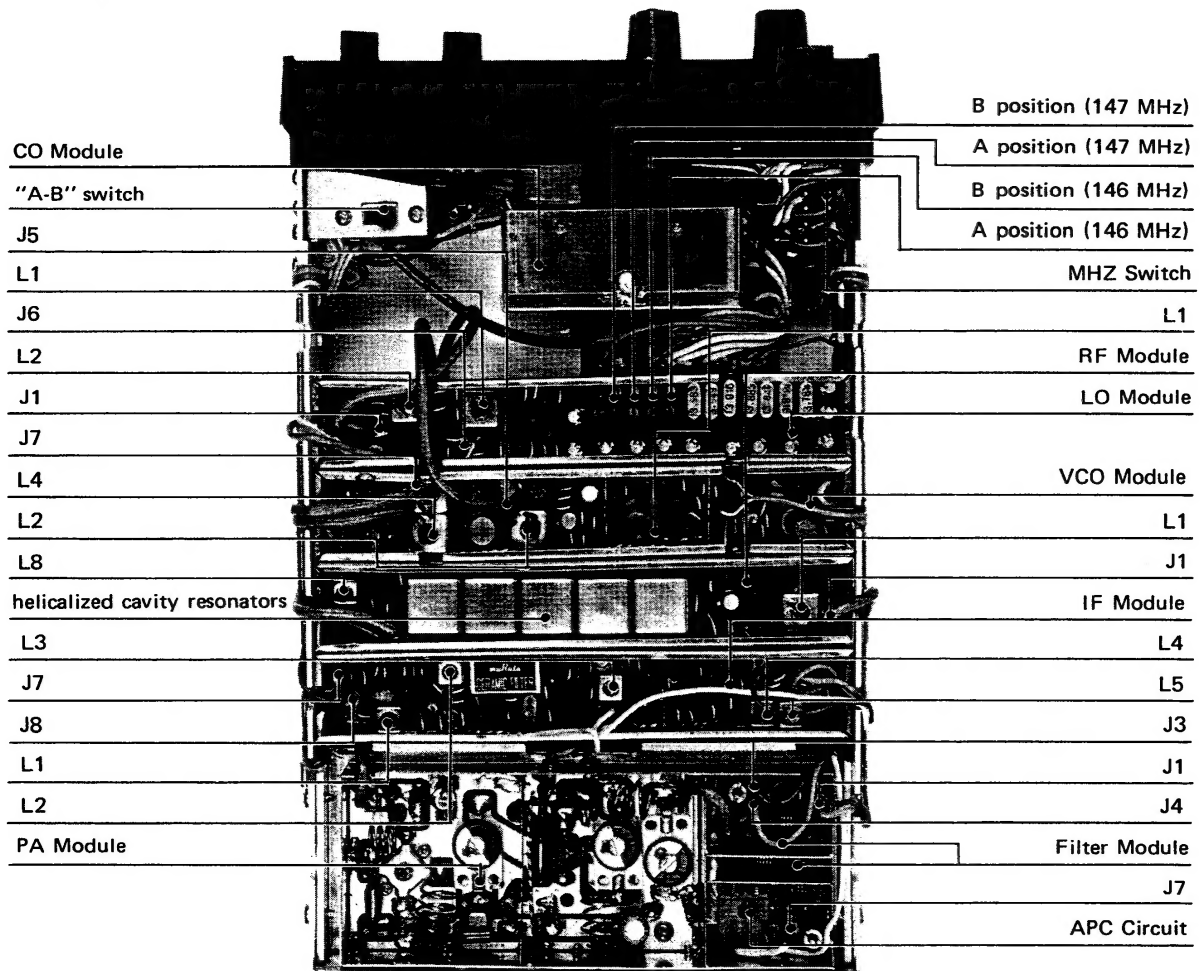
External Speaker Jack: this jack mates with the plug supplied for an external 8 ohm speaker or headset use.



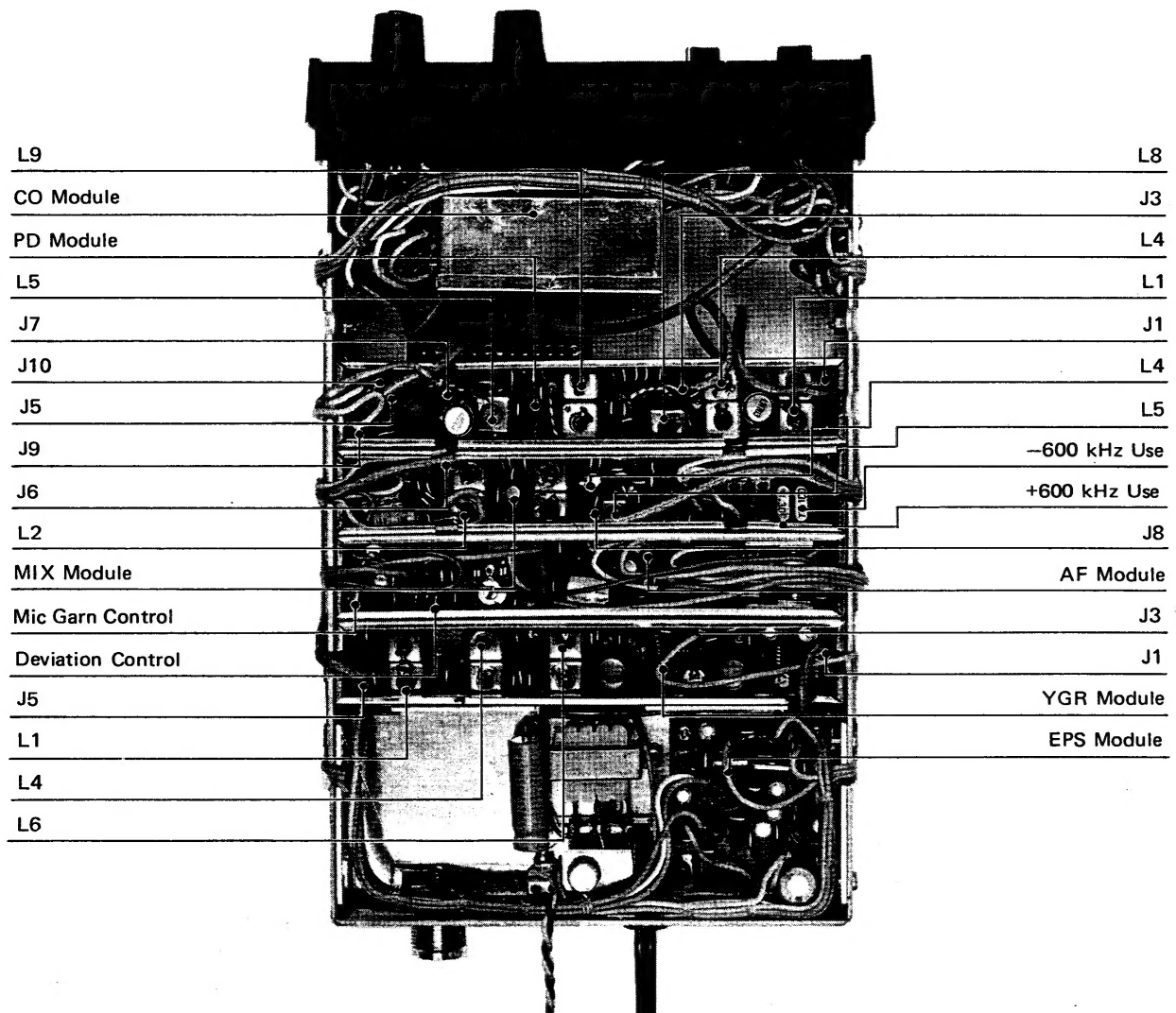
Power Receptacle: mates with DC cord plug supplied.

Identification Plate: states model, serial number and date of manufacture.

TOP VIEW



BOTTOM VIEW



5.1 Initial Preparations:

- ## 5.2 Operation:

- For example, 146.52 MHz is shown by “146” on the MHz Indicator, “5” on the 100 KHz Selector and “2” on the 10 KHz Selector. (See Chart 1)

LO Freq CO Freq	MHz	13,783 (124,045)	13,816 (124,345)	13,849 (124,645)	13,883 (124,945)	13,916 (125,245)	13,949 (125,545)	13,983 (125,845)																	
MHz	100 KHz	0	1	2	3	4	5	6	7	8	9	A	B	0	1	2	3	4	5	6	7	8	9	A	B
11,355	0																								
11,265	1																								
11,475	2																								
11,385	3																								
11,295	4																								
11,505	5																								
11,415	6																								
11,325	7																								
11,535	8																								
11,445	9																								
	C																								
	V																								
		146 (MHz)												147 (MHz)											

5.3 Reception:

- 10-

5.4 Transmitting:

- a. Push the PTT (push to talk) button on the microphone and the transceiver will transmit: A red transmit indicator lamp comes on below 100 KHz Selector and the meter will provide an indication of relative power output of the transmitter. The needle will be on or near the eight mark on the meter scale.
- b. Hold the microphone about three inches from your mouth and speak in a normal voice. Shouting does not increase your communication range. The microphone is of the dynamic type and provides good pickup for all levels of the voice.
- c. To receive again, just release the PTT button.

5.5 For Repeater Use:

You may transmit at either 600 KHz above or below the receive frequency for Repeater use. To decrease the transmit frequency place the "A-B" Switch in the "A" position: to increase the transmit frequency, place the Switch in the "B" position.

CAUTION DO NOT USE THE REPEATER SWITCH IN THE "B" POSITION IF YOU ARE OPERATING ABOVE 147.39 MHz. THE TRANSMIT FREQUENCY WILL BE ABOVE 148.00 MHz.

SECTION VI - THEORY OF OPERATION

P.L.L. Synthesizer (Phase Locked Loop)

The P.L.L. consists of four modules: Voltage Controlled Oscillator; Phase Detector; Local Oscillator; and Comparison Oscillator.

6.1 VCO and PD Module

This is a self oscillating circuit with a frequency range of 135.31 to 137.29 MHz, which is mixed with a 10.7 MHz signal. The result is a frequency of 146.01 to 147.99 MHz. The frequency of the Hartley oscillator is determined by L1, C9, D1. D1 is a variable capacitance diode. The capacitance is altered by the voltage at either side. With the time constant of R6, R8 and C4, when Q3 is cut off, Q2 a unijunction transistor, generates a sawtooth voltage which is fed to the VCO through R11. The VCO will then sweep from about 134.5 to 138.5 MHz.

The amplitude of the sweep is controlled by the anode voltage of D1 with potentiometer R13.

As an example, if an LO frequency of 124.045 MHz is selected, and the CO frequency is 11.265 MHz, the output of the VCO begins to sweep at about 134.5 MHz. As the frequency reaches 134.31 MHz, the output from the PD increases and being fed to the gate of Q3 causes it to conduct. The voltage dropped by R8 decreases, causing the increasing voltage at CP1 to stop, and the frequency of the VCO is held at exactly 135.31 MHz. If the frequency of the VCO increases slightly, because of some change of the constants in the circuit, the output of the PD becomes negative causing the output of Q3 to decrease, the voltage at CP1 increases, and the frequency of the VCO is kept as accurate as the Crystal controlled LO and CO.

The output of Q2 is fed to the mixing module after pulse components are amplified by Q1 to be used in indicating "locked" or "unlocked" condition.

6.2 LO Module

The Local Oscillator frequency is used with the VCO frequency to form an intermediate frequency, which is compared with the CO frequency in the Phase Detector circuit. Q1 is a crystal oscillator whose base is connected to one of 7 crystals selected by switch So1. So1 is the 100 KHz selector on the front panel. The output of Q2 a buffer amplifier, is fed to a tuning circuit consisting of L1 and C30. This circuit is tuned to 13 MHz.

After being stepped down by the secondary of L2, the output is fed to the phase modulator bridge circuit R9, R10, R11, L2, and D1. L2 and D1 are tuned to 13 MHz and then the bridge circuit is balanced. The circuit loses this balance because of changes in capacitance of D1 supplied with an AF signal through J6, so the RF signal is Phase Modulated by the AF signal. This modulated signal is fed to the PD module through Q3, a buffer amplifier.

6.3 CO Module

The CO frequency is compared with the VCO frequency in the PD. Q1 is a crystal oscillator whose base can be connected with any one of 10 crystals for 10 KHz, a spare crystal or External VFO by switch S1 which is the 10 KHz knob on the front panel. Each crystal frequency can be adjusted by the trimmer next to each socket. The output taken from the emitter of Q2 is fed to the PD after being amplified by Q2.

6.4 Tx and Mix Module

The Transmitt signal is composed of a 10.7 MHz frequency, generated in the Mixer module, and the frequency generated by the VCO. The base of Q8 is connected to one of three crystals, X1, X2 or X3, and oscillates with extremely good stability. These three crystals are selected by the direct or repeat switch on the front panel, and by either "A" or "B" of the switch on the top of the case. Each of the crystals can be adjusted by the trimmer located next to the crystal socket.

The frequency which is mixed in the mixer module with the PLL frequency is 10.7 MHz in direct mode, 11.3 in the A position, and 10.1 in the B position of the Repeat mode.

Q7 is a buffer amplifier, the collector circuit of which is tuned to about 10.7 MHz with the coil LS7.

Q6, an 3SK40, Dual Gate FET, composes a signal of 147 MHz. A signal from the VCO is fed into of Q6 through J8.

The Q4 drain circuit is tuned to 146-148 MHz by means of a double tuned band pass filter. Q5 is a buffer amplifier, the drain of which is connected with the same band pass filter to attenuate spurious signals by more than 60db. From the linked coil coupled with the end of the filter, the signal is fed to the PA module by way of a coaxial cable of 50 ohms, through J6.

Another important circuit is located in the Mixer module. It is a control circuit to stop operation and prevent spurious signals from going out when the VCO is unlocked. A pulse sweeping signal in the VCO is fed into Q1 of the Mixer module through J1 and J2 and the pulse is amplified by the complementary amplifiers Q1 and Q2.

The collector of Q2 is driven positive and rectified by D9, fed to the base of Q4 through R4 which drives Q4 on. When Q4 is on the collector circuit connected to the EPS circuit through J5 cuts off the power to the P.A.

At the same time the collector output from Q2 is fed to the base of Q9. Q9's collector is taken out of J3 to be grounded to a lamp. Though Q9's base bias current is sufficient to draw collector current to properly illuminate the lamp when Q9 has no pulse input, (for example when the PLL works normally) the pulses reduce the collector current so that the meter lamp becomes dim.

Abnormal operation of the P.L.L. circuit is probable with low power supply voltage. To avoid this the following circuit is employed. Q3 is an N-gate Thyristor. This is the programmable unijunction transistor (PUT), which has the characteristics that a circuit is closed when the anode voltage exceeds the gate voltage. The anode is charged by the voltage regulated by D2. The gate is charged by the voltage divided out of the power supply circuit in order to get higher voltage than the anode at normal supply voltage. When the power supply voltage becomes lower than that set up for firing the gate of Q2 becomes lower than the regulated anode voltage. Q3 then turns on and feeds R10 voltage. The voltage fed from R10 to the base of Q4 is also fed out J4 after passing through D4. This drives the squelch circuits closed to short the audio circuit. Such operation also cuts off power to the transmit section so that no spurious will be radiated.

6. 5 Receiver RF Amplifier and First Mixer Module

The input signal is amplified by the field effect cascade amplifier, Q1 (3SK40), and passed into the RF filter: This filter is a high Q helicalized resonators with excellent bandpass characteristics and shockproof construction. From the output of the helicalized resonators the signal is fed to the gate of the first mixer, Q2 (2SK19) where it is mixed with the output from VCO, which is fed into the source of Q2 to obtain the 10.7 MHz of IF signal. The output of the mixer is fed through the first ceramic filter FL 1 (SFC 10.7 MA) to the IF amplifier. All the transistors in the receiver RF unit are field effect transistors, which have the highest possible sensitivity and signal to noise ratio and the lowest possible cross modulation.

6. 6. Receiver 1st IF amplifier, 2nd IF amplifier, Limiter and Discriminator Module

The 10.7 MHz signal from the first ceramic filter in the RF unit is amplified by Q1 (2SC372) and fed to the gate of the 2nd Mixer Q2 (2SK19) through the 2nd ceramic filter FL 1 (SFC 10.7 MA). The variable resistor in the emitter circuit of the First IF transistor Q1 adjusts the IF gain and S-meter sensitivity. The 2nd Oscillator Q9 (2SC372) is crystal controlled and operates on 10.245 MHz. The output is taken from the emitter of Q9 and fed into the gate of the 2nd Mixer Q2 (2SK19) to obtain the 455 KHz. IF signal, which is passed through the 3rd ceramic filter FL 2 (CFP 455E) and amplified by Q3, Q4, Q5, Q6, Q7 and Q8 (2SC372s). The output of Q8 is then demodulated in the discriminator circuit, consisting of L4 (LS-14), L5 (LS-15), and D7 and D8 (1N60s).

6. 7 Receiver Audio Amplifier, Squelch Amplifier Module

The output of the discriminator drives two circuits the audio amplifier and the squelch. The audio signal, after being adjusted by the volume control R-1, is then fed to IC 1 (TH9004AP), followed by the audio power amplifier stage Q8 and Q9 (2SD235s), which gives an audio output of 1.5 watts.

The squelch circuit is made up of Q5, Q6 (2SC372s), Diodes D3, D4 (1N60s), and Q7 (2SC373). In the absence of a signal, the noise component at the output of the discriminator is amplified by Q5 and Q6. Diodes D3 and D4 rectify this amplifier component, Q7 couples it through the 10 K ohm R-2 squelch control to the DC amplifier and Q7's output is coupled directly to the base circuit of IC 1. When the squelch control is adjusted, the amount of DC required to cut off IC 1 is found, thus establishing the squelch threshold. When a signal is incoming via the discriminator, this bias is overcome, permitting the audio amplifier and driver to perform normally.

The signal from the microphone is amplified by Q1 and Q2 (2SC372s), fed to the deviation limiter, which consists of D1, D2 (1N60s) and the active audio filter Q3 (2SC372), and further amplified by Q4 (2SK30) before being fed to the modulation circuit in the Mix unit.

6.8 EPS Module

This circuit provides a source of regulated voltage for all the circuits and control of output power during antenna mismatch conditions, as described below. All the circuit voltages except YGR and PA stage, are regulated to about 9 volts by the two series pass transistors Q5 and Q6 and D5. The circuit consisting of Q7 and Q8 is a switchable power supply for transmit and receive, using NPN and PNP transistors instead of a relay. J8 is grounded by the microphone push to talk switch being pushed. The base of Q7 (2SD235) will be also grounded through D4 so that the voltage at J7 for receiver power will become zero. In the opposite way, when J8 is not grounded by the switch, the base of the Q8 has a positive voltage so that the voltage at transmitter power will become zero. J1 is to the APC circuit and J2 to the transmit mute circuit. Q6 is a power supply for receiving circuit: J6 is 9 volts and J7 is 13 volts. Q7 is also a power supply of 9 volts.

6.9 YGR (Pre-driver) Module

The modulated 147 MHz signal from the Mix Module, is amplified by Q1 and Q2 (2SC784s). Double tuned circuit are used twice between the stages to minimize spurious response. The signal through the next double tuned circuit is amplified by Q4 (2SC741) and Q5 (2SC730) to a power level of one watt. This signal is fed into the power amplifier.

6.10 Transmitter Power Amplifier and Transmitter Automatic Protection Circuit (APC) module.

The signal from the YGR is amplified to 10 watts by transistors Q1 (2SC1011) and Q2 (2SC1177). Transistor Q2 is the power output stage and is coupled to antenna through the spurious filter consisting of L8, L9 and L10 and the Automatic Protection Circuit.

The APC acts to decrease the power output of transistors Q1 and Q2 if the antenna is seriously mismatched. A reflected power detector is provided by L11 (V9T-02) and D2 (1N60). When the antenna is mismatched, this circuit senses a high reflected power and provides base drive to transistor Q1 (PS) in Power Supply unit. This transistor will conduct sufficient base drive to reduce the base drive of transistor Q2 (PS).

When transistor Q2 (EPS) begin to cut off it reduces the drive to the complementary transistor pair, consisting of Q3 (EPS) and Q4 (EPS). This pair acts as a series regulator for the voltage supplied to the driver transistor Q1 and the power output transistor Q2. When they begin to cut off, due to a lack of base drive, the voltage being supplied to Q1 and Q2 is reduced to about six or eight volts which reduces the power output to safe level. This lower power prevents damage to Q1 and Q2 when the antenna is mismatched.

SECTION VII - MAINTENANCE

7.1

The necessity of completely realigning the unit is unlikely. The most common cause of breakdown is component failure. It is felt that the average owner would not have the necessary equipment and facilities to accomplish realignment in any case, if it did become necessary. Great care and precision are employed in its manufacture, and service is provided to ensure it meets specifications. Adjustments not outlined herein should not be undertaken by the owner.

Do not attempt to adjust these under any circumstances.



ALIGNMENT CHART (Chart 2)

IC-230 VOLTAGE CHART

MODULE	NO.	NAME	BASE	EMITTER	COLLECTOR	DRAIN	ANY OTHERS
RF	Q1	3SK40	0(G)	2.8(G)	0.2(S)	7.2(D)	
RF	Q2	2SK19	0(G)	1.1(S)	8.1(D)		
AF	Q1	2SC372	0.3	0.03	1.4		
AF	Q2	2SC372	1.4	0.8	6.5		
AF	Q3	2SC372	7.0	6.7	8.4		
AF	Q4	2SC372	7.0	0.8(S)	4.0(D)		
AF	Q5	2SK30	0(G)	0	6.0		
AF	Q6	2SC772	0.7	0.6	7.0		
AF	Q7	2SC372	1.2	0	5.0		
AF	Q8	2SC373	0.7	6.5	13.5		
AF	Q9	2SD235	7.0	0	6.5		
IF	Q1	2SD235	0.7	1.2	8.2		
IF	Q2	2SK19	0 (G)	1.3(S)	8.0(D)		
IF	Q3	2SC372	0.7	0	2.4		
IF	Q4	2SC372	5.8	5.2	6.1		
IF	Q5	2SC372	0.7	0	1.0		
IF	Q6	2SC372	2.8	2.3	3.4		
IF	Q7	2SC372	5.2	4.9	6.0		
IF	Q8	2SC372	1.0	1.1	7.0		
IF	Q9	2SC372	1.8	2.0	7.3		
CO	Q1	2SC372	2.5	2.6	8.6		
CO	Q2	2SC372	2.3	2.8	9.0		
LO	Q1	2SC372	2.4	2.0	8.0		
LO	Q2	2SC372	2.0	1.4	7.8		
LO	Q3	2SC372	1.7	1.1	3.2		
PD	Q1	2SC784	1.2	0.6	8.4		
PD	Q2	2SC372	0.8	0.6	8.5		
PD	Q3	2SC784	1.2	0.6	8.6		
PD	IC1	LM703	8.0	1.4	0	1.4	8.0 8.4
PD	IC2	LM703	8.0	1.4	0	1.7	8.0 8.4
VCO	Q1	2SK30	4.7(G)	4.5 (S)	1.3(D)		LOCKED STATE
VCO	Q2	2SH16N	4.8	0	5.8		LOCKED STATE
VCO	Q3	2SK30	0.25	1.0	4.5		LOCKED STATE
VCO	Q4	2SC784	1.0	1.0	7.8		LOCKED STATE
VCO	Q5	3SK40	2.3(G1)	0(G2)	0.8(S)	8(D)	LOCKED STATE
VCO	IC1	LM703	7.7	1.4	0	1.4	8.0 7.7
MIX	Q1	2SC372	0	0	12		LOCKED STATE
MIX	Q2	2SA562	12	12	0.6		LOCKED STATE
MIX	Q3	NI3T1	7(G)	7	5.6(A)		LOCKED STATE
MIX	Q4	2SC372	0	0	13.8		LOCKED STATE
MIX	Q5	3SK40	0(G1)	3.3(G2)	0.4(S)	8.8(D)	
MIX	Q6	3SK40	1.4(G1)	2.6(G2)	1.4(S)	6.8(D)	
MIX	Q7	2SC372	2.6	2.0	8.4		
MIX	Q8	2SC372	2.8	2.0	8.6		
YGR	Q1	2SC784	2.3	1.5			
YGR	Q2	2SC784	2.2	1.5			
YGR	Q3	2SC741	0.6	1.0			
YGR	Q4	2SC730	0.6	0			
PA	Q1	2SC1011					
PA	Q2	2SC1177					
EPS	Q1	2SC372	0.6	0	8.0		TRANSMIT
EPS	Q2	2SC372	7.5	11	13.0		TRANSMIT
EPS	Q3	2SA695	13.0	13.0	13.0		TRANSMIT
EPS	Q4	2SD235	13.0	13.0	13.0		TRANSMIT
EPS	Q5	2SC1209	9.2	8.4	13.0		TRANSMIT
EPS	Q6	2SC1209	0.5	0.2	0.5		RECEIVE
EPS	Q7	2SC235	0.8	0.5	13.0		RECEIVE
EPS	Q8	2SB435	13.0	13.0	13.0		RECEIVE

INOUE COMMUNICATION
EQUIPMENT CORPORATION

3-8 KAMIKURAZUKURI-CHO,
HIGASHISUMIYOSHI-KU,
OSAKA JAPAN
